Tennessee River Gorge Project

A Literature Review Concerning the Application of GIS and Scientific Information in Community Planning and Decision-making

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Technology in Planning

Al-Kodomany, Kheir. (1998). Advancing Visual Thinking for Planners: The Use of Imaging Technology. *EDRA, 29,* 25-32.

      Al-Kodomany states in this article that images should be a means to planning, not an end. Planners should produce images in order to think, discover and test ideas. A planner should use images that allow him to make connections between ideas and visuals. These type images are referred to as "thinking images." Thinking images can be used to represent beginning thoughts, reactions to site and program, and/ or possible solutions.

      One effective technique for creating thinking images is overlay analysis. This method allows analyzing spatial and component relationships. This is accomplished by overlaying individual images that contain different details and information about a common geographic area. Overlay analysis has been advanced greatly by scanning technologies. Layers can be created by scanning images into the computer. Scanning allows planners to use actual photos in the overlay analysis, which helps create a greater sense of reality to the final image.

      Adobe Photoshop is one computer program that assists in layering and photo-manipulation. This program was used by city planners in Fort Collins, Colorado, to demonstrate the effects of a zoning code requiring "big box" retailers to use higher quality materials on their facades. Layers were used to demonstrate the differences in appearance of a typical Wal-Mart and one constructed with higher-quality materials. This type of visualization technique also provides the public with insight into the purpose of such ordinances. In addition to building facades, layering can also be used in reference to "streetscape treatments, architectural styles for in-fill development, and elevation renderings."

      Overlay analysis produces images that are explicit. Both planners and non-planners can understand these images. This technique also allows planners to convey the reasoning behind certain decisions to the public. Al-Kodmany expresses the importance of incorporating such imaging techniques throughout the planning process.

Al-Kodmany, K. (1999). Using visualization techniques for enhancing public participation in planning and design: process, implementation, and evaluation. *Landscape and Urban Planning, 45 (1),* 37-45.

      This article describes a study conducted in Chicago that used GIS, freehand sketching, and photo-manipulation to enhance public participation in the planning process for Pilsen neighborhood. Benefits of broad-based community involvement in planning include creating a stronger sense of commitment in citizens, increasing user satisfaction, creating realistic expectations of outcomes, and building trust between planners and city officials and the public. Public participation also allows planners and designers access to community expertise and local

knowledge, which leads to better plans and designs. Visualization is key to involving the community in this process, because it allows technical and non-technical participants to relate to the information. Advances in digital visualization techniques have changed and enhanced the way citizens can influence planning and design decisions.

The goals for the community focused on promoting commercial tourism along the business corridor, and at the same time address issues of urban blight and decay, vacancies, and crime. The planning team consisted of 25 community residents, and from the University of Illinois at Chicago, two architects, two planners, and one artist.

Visualization proved to be key in engaging the residents. At the first meeting, slides were set and presented in a fixed sequence to display current site conditions. This process lacked the ability to produce specific slides as residents asked questions. This process also lacked a means of visualizing what was being proposed within the context of what currently existed, and this is necessary for citizens to participate to the fullest extent possible.

The GIS was used to create a database of maps and tabular data, mainly at the parcel level. This included data on demographics, transportation, housing and property, historic districts and landmarks, economics, and crime. Hypertext links were added to the maps to show existing conditions and historic sites. The GIS was supplemented with an artist. This allowed ideas to be quickly transformed into drawings. The artist used an electronic sketch board to construct scenes described by the citizens. These scenes could then be saved to a disk. These sketches portrayed the audience's concerns and wishes in a clear and simple manner. The pictures were recorded with date and time, so those who were not at a previous meeting could recreate the flow of the conversation.

The GIS and artist were used in the first set of meetings. The GIS helped display existing conditions, and the artist helped create potential outcomes. This allowed citizens to be involved in the development of the plans, rather than just viewing a final plan. These visualization methods helped the citizens reach a consensus on such issues as sidewalks. Once everyone realized the dangers to pedestrians in the areas with no sidewalks, and the potential boost sidewalks could bring to businesses, the community members agreed on the need for sidewalks. This type of communication also informed planners that large trees could not be placed along the street due to the design of the sewer system. This prevented an inaccurate image of what was realistic.

The artist's sketches were then used as a basis for creating computer-aided photo-manipulated scenes. The goal was to help citizen make final decisions on design issues by allowing them to see what results these decisions will look like in the neighborhood context. This provided a more realistic image than the sketches. Photo-manipulation was also used to illustrate the effects of a new zoning code that was being considered. The proposed code would require "big box" retailers (i.e. Wal-Mart) to use higher quality materials on their facades. This gave the residents insight into the purpose of the ordinance and helped them to visualize the effects of alternative building materials. The planning team agreed that the same level of participation would not have been reached with more traditional tools such as slides, handouts, and group discussion.

Each visualization tool was also evaluated. The GIS required transporting a large amount of equipment, and technical difficulties were frequent. Also, it was expensive to develop the GIS. However, the GIS was critical to the success of the project, and the benefits outweighed the drawbacks.

There were no real drawbacks to the sketch artist. The artist provided a human touch to the process and produced immediate results. This element also allowed the team to retrace the process and find bad decisions or unexpected alternatives.

The main drawback to the photo-manipulation was that it was very time consuming. This process took a considerable amount of preparation. The highly realistic images helped the

audience make communal decisions more easily. "The appropriate context in using computer-aided photo-manipulation in community planning is at the final decision-making stage."

Arnold, Jr., C. L., Civco, D. L., Prisloe,Jr., M. P., Hurd, J. D., and Stocker, J. W. 2000. Remote-sensing-enhanced outreach education as a decision support system for local land-use officials. *Photogrammetric Engineering and Remote Sensing, 66 (10),* 1251-1260.

This paper looks at three projects that the University of Connecticut is involved with that explore the capabilities of remote-sensing (RS) based decision support systems for local land-use officials. The three programs are the NEMO Project, Connecticut River Watershed Project, and the NAUTILUS Project. The NEMO Project deals with town level decisions, the Connecticut River Watershed Project focuses on watershed decisions, and the NAUTILUS Project works with specific tools to combat urban sprawl. This paper proves that RS information can be an important tool for planners and decision makers in planning growth for their community when it is integrated with applications and outreach to form tailored decision support systems.

Bell, M., Dean, C., and Blake, M. (2000). Forecasting the pattern of urban growth with PUP: a web-based model interfaced with GIS and 3D animation. *Computers, Environment, and Urban Systems, 24 (6),* 559-581.

Projections for Urban Planning (PUP) is a model used to forecast the location of housing development and population growth on the fringes in larger cities. "The model couples the land use and housing unit methods of population forecasting in a GIS frame work that delivers a seamless interface between data assembly, modeling, visualization, and analysis." The user can get analysis results in GIS compatible files, in tables, or in 3D animations with interactive querying. The generic structure of the model creates a flexible, interactive forecasting system that can be adapted to provide decision support for urban planning in a range of urban settings.

Planners need detailed forecasts of human population growth and housing development to provide the physical infrastructure and human services required by new development. This system provides planners with a way to forecast this information. The implementation of most land use models encounters many problems. Most models are highly data-intensive, and data assembly is very time consuming. It has also been difficult to model the spatial relationships that affect the urban form with conventional programming language. A third problem has been conveying the results of a large output matrix to users in a clear and understandable way.

There have been two widely recognized methods of forecasting. One is the Cellular automata model. This analogue approach attempts to simulate growth of entire cities or regions. The second type of models is defined by their attempt to embody real world processes. This approach is used for planning and decision-making that focuses on small areas of a city. The PUP model falls into this second category.

The PUP user enters scenario parameters into a HTML form. The model then produces a range of outputs. The user can then view the results or run a different scenario using a new set of parameters. In this case, PUP generates forecasts for three key variables: population growth, dwellings, and allotments. These results are usually returned in tabular form, but the graphic user interface also allows the user to select a specific variable and style for visualization, either as annual or cumulative data. The model can also calculate the difference between successive runs and hence to visualize the effects of altered parameters. The user can choose whether to get results for the entire study region or a selected area.

The use of GIS and animation significantly enhance the generation and analysis of the results. The PUP uses VRML to animate the forecast results. VRML provides for a flexible

viewing of thematic 3D displays by way of colored geometric objects and for displaying temporal aspects through animation. VRML has been used in a number of urban planning applications to display 3D images of urban settlement.

PUP provides a framework for scenario generation and decision support. In Adelaide, Australia, this model was used to produce visually displayed scenarios of various zoning patterns. PUP extends existing modeling applications in three ways:

1. Through enhancements to the forecasting technique
2. Through refinements to input and output processing
3. By facilitating access and portability (Implementing the model as a web-based, online application, and using widely available technologies i.e. HTML and JavaScript)

Campana, Nestor A., and Tucci, Carlos E. M. (2001). Predicting floods from urban development scenarios: case study of the Diluvio Basin, Porto Alegre, Brazil. *Urban Water, 3 (1-2),* 113-124.

This paper illustrates how a hydrologic model was used with GIS display scenarios on urbanization and the effects they would have on flooding. The GIS consisted of two modules: (1) geo-processing and (2) digital image analysis. Topographical data was used to create the digital elevation model (DEM). Soil type and land use were used along with the digital terrain model (DTM) to calculate the time of concentration, time-area histogram, infiltration parameters, and impermeable areas. Data sources for the project included satellite images, maps of soil type, geology, topography, and urban occupation, and hydrological records of basin rainfall and runoff. Fieldwork was necessary to update some of these sources. The hydrologic-hydrodynamic model simulated the rainfall-runoff process and represented channel and conduit flow.

One of the main challenges of controlling urban drainage is to identify the likely effects of urban development at the planning stage. The model was used to simulate four scenarios. Scenario 1 was the 1980 scenario; Scenario 2 was the 1990 scenario, which was similar to the current conditions; Scenario 3 was the vision of the Master Plan with permeable free space in building lots; and Scenario 4 was the realistic Master Plan, with 50% of free space impermeable because this was believed to be what really happens. The results showed that the Urban Master Plan would increase the peak flow by 20-50% compared to Scenario 1. This illustrates how GIS can be used to test some long-term effects of an area's Mater Plan, and how problems can be identified before they become a reality.

Center for International Earth Science Information Network. University of Columbia. 2001. www.ciesin.columbia.edu

CIESIN is a non-government, non-profit organization established in 1989. CIESIN is based at Columbia University. It provides scientists, decision makers, and the public with information to better understand the changing world. This organization specializes in global and regional network development, decision support, and training, education, and technical consultation services.

Their website offers interactive applications that include an interactive order of 1990 census data in prominent GIS data formats, access to scenarios of the future greenhouse gas emissions, and the ability to create correlation lists between various US geographies. The web site also includes an international catalogue of metadata resources that allows a user to locate environmental and socioeconomic data. The site also includes a list of other data resources and information system.

Center for Science, Policy, & Outcomes. 2001. www.cspo.org

This is the website for the Center of Science, Policy, & Outcomes. This organization deals with how science can be used to improve quality of life for the largest number of people. The goals of the CSPO are:

- To advance understanding about connections between science and societal outcomes.

- To evaluate how well existing science initiatives achieve outcomes.

- To describe and develop new policy frameworks that can help increase the positive outcomes of science, prevent or reduce the negative ones, and extend benefits to disadvantaged populations.

- To support the efforts of decision-makers to craft outcomes-based science policies.

- To provide educational opportunities in the area of outcomes-based policy making.

This organization strives to create policy based on the outcomes of scientific research, not the idea that more science automatically leads to better social outcomes, which is the way science policy has been created since WWII.

Hall, Simon. Community Networks: Community Development Through Information Technology. *Online Planning Journal,* http://www.casa.ucl.ac.uk/planning/articles11/cn.htm

One of the expectations of advanced technology is that it will provide an opportunity for equal citizen participation in government processes. However, unequal access to these technologies due to income, education, language, or other barriers will continue to deny certain portions of the population an equal voice. One method of dealing with this issue is the idea of community networks.

A community network "consists of a network of computers with modems that allow users to connect to a central computer which provides community information and a means for the community to communicate electronically." This idea is based on a five assumptions. The first is that the new communication technologies will be increasingly important to the economy and society. The second assumption is that this process will lead to a more democratic process by providing access to discussions for groups of people who are generally excluded from them. This provides a forum that is not restricted by time, location, or social status. The third assumption is that the communication technologies will reinforce face-to-face communication by improving the chance for groups and individuals to discuss issues and arrange meetings. It is also assumed that the telecommunication infrastructures are a public utility. The final assumption is that developments in information technology will remain practical and desirable.

Unlike the Internet or the World Wide Web, community networks are placed based. Community networks focus on local issues, local culture, local relevance, and local pride. They provide a forum where neighborhood citizens can communicate and participate in problem solving. This type system also provides citizens with information they would not have had access to otherwise.

Hartman, G. K., Noelle, A., Richards, M. L., and Leitinger, R. 2000. DUST-2: Towards a more efficient (interactive) documentation and validation of scientific information demonstrated with ozone, water vapor and other selected data of the Earth's atmosphere. *Physics and Chemistry of the Earth, Part A: Solid Earth and Geodesy, 25 (8),* 607-612.

The DUST-2 concept is a first step in developing an interactive, flexible interface and qualifying filter matching several different non-uniformly formatted data resources. This product provides the retrieval of qualified information through graphical methods.

Hoch, Charles J., Linda C. Dalton, and Frank S. So. 2000. *The Practice of Local Government Planning, Third Edition.* International City/County Management Association. Washington D. C. 19-57.

Level	Definition	Role in computing
Data	Observations about people, places, natural features, or other entities that have been recorded and stored	1960s—Electronic data processing (EDP): conversion of data from paper records to machine-readable format to facilitate routine operational tasks
Information	Data that have been organized, analyzed, and summarized into a meaningful form	1970s—Management information systems (MIS) and geographic information systems (GIS): organization and structuring of digital data to serve management purposes
Knowledge	Understanding based on information, experience, and study	1980s—Decision support systems (DSS): use of digital information, models, and output displays to deal with complex problems and support executive decision making
Intelligence	Ability to deal with novel situations, to apply knowledge acquired from experience, and to use reasoning to guide behavior	1990s—Planning support systems (PSS)—integration of computer-based information, models, and tools to support collaborative planning and community decision making

Data Hierarchy

1960s	Planning as applied science: Information technology provides information needed to support a rational and value-neutral planning process.
1970s	Planning as politics: Like planning itself, information technology is inherently political, reinforcing existing structures of influence, obscuring underlying political choices, and shaping the policy-making process.
1980s	Planning as communication: Information technology and the content of planners' technical analyses are often less important than the ways in which planners transmit information to others.
1990s	Planning as reasoning together: Information technology helps facilitate communication, community decision making, and collaborative planning.

Evolving Views of Planning and Its Relation to Information Technology

The first part of this article can be summed up by the above charts. The first illustrates the hierarchy of data as recognized by planners. Data falls at the lowest end of the scale and intelligence is at the top. This chart also describes the role of technology at each level of information.

The second chart describes how the idea of planning has changed over the past 30+ years. The second chart also shows how each stage of planning was related to the technology of the time.

This article claims the three most important technologies used by planners today are; electronic spreadsheets, geographical information systems (GIS), and the Internet. Planners gain three advantages from electronic spreadsheets:

1. They are easily accessible and highly useful,
2. They are adaptable, and
3. They are perfect for examining "what if" questions for analysis.

Spreadsheets provide a means to analyze any quantitative problem that can be presented in a two-dimensional table. Spreadsheets save time by eliminating the need for repetitive work. This technology allows planners to determine certain effects, such as cost, of a few different assumptions and policy decisions in a short time easily.

GIS is used to capture, store, analyze, and display spatial data. GIS is used to create informative maps that make spatial data very easy to interpret. It also provides the ability to store attribute data for features on the map. It makes the analysis of spatial relationships such as nearest, farthest, or inside easy to figure out. Today there is a large amount of data available via the Internet that can be used in GIS. One example of this readily available data is information from the US Census Bureau. This data is usually offered in larger areas, such as census tracts or block levels. Detailed data at the level of individual parcels of land is still quite expensive to obtain. GIS is most valuable to planners when used with large-scale data on individual parcel land use, development controls, ownership, etc.

Planners began developing Planning Support Systems (PSS) in the late '90s to best utilize GIS technology. These systems combine GIS with other computer-based tools such as spreadsheets, custom written programs, and the Internet. The main goal is to create fully integrated, flexible, and user-friendly systems that combine (1) spatially based GIS, textual, graphic, and visual information, (2) a broad range of computer-based models and methods for determining the implications of alternative assumptions and policy choices, and (3) a variety of visualization tools for presenting the results of the models, charts, maps, etc.

Web technology can have many positive effects on the planning process. It creates an opportunity for more people to participate in decision-making. This creates a discussion with many more points of view and insights than would be possible. This technology allows draft plans and proposals to be placed on a web site for public review and comment. GIS and 3D modeling are crucial in helping people who are not scientists or planners understand the information, so that they can be well-formed participants in this process.

Planners use two types of data: primary and secondary data. Primary data is that which the planner obtains through direct observation, interviews, surveys, and remotely sensed images from satellites and/or airplanes. Secondary data is data that has been collected by others, i.e. US Census data. The Internet and improved information sharing techniques have greatly improved locating and accessing secondary data.

Planners use models to help predict future conditions. Models are simplified representations of the world that can be manipulated. Today almost are models are computer-generated models. One type of these models is a simulation model. Simulation models attempt to duplicate the operation of natural and human made systems. Technological advances have made simulation models much more available to planners in the past few years.

Reporting the information not only conveys the conclusion and recommendations of the planner, but it also involves the public, elected officials, NGOs, etc., in the decision making process. "Computer-aided visualization can help promote community participation by rendering information more understandable, credible, and usable to different segments of the public, especially those who have not had access to, or experience with more traditional forms of information."

"The widespread development of multi-agency parcel-level GIS will provide planners with a wealth of detailed information on local land uses, infrastructure, and natural features that could only be dreamed of previously. High-speed access to the Internet will allow planners and the public to retrieve vast quantities of spatial information from their own computers, from department or governmental databases, or from anywhere in the world, and never know where it was stored."

"The increased availability of information, improved data dissemination, and visualization technologies, and the ability to conduct meetings unconstrained by location or time will greatly enhance the public's access to and understanding of government information."

Kingston, R., Carver, S., Evans, A., Turton, I. (2000). Web-based participation geographical information systems: an aid to local environmental decision-making. *Computers, Environment, and Urban Systems, 24 (2),* 109-125.

These researchers focus on the use of Web-based GIS as a means of bringing the public closer to a participatory planning system. This paper identifies key themes evolving in this area, and provides a case-study example of an online public participation GIS from inception to the final phase in a public participation process. One conclusion drawn in this article is that participatory online systems are a useful means of informing and engaging the public, at least those with access to the Internet and the Web.

The use of a real decision-making problem is key to the proper development of a Web-based GIS. This approach provides a focus for the research and development work, and creates public interest by dealing with a real issue.

A case study takes place in Slaithwaite, a village in northern England. The planning process for the U.S., especially the public's role in this process, seems very similar to the process described in this paper. Public participation usually occurs when citizens attend planning meetings. Many times these meeting take place in an atmosphere of confrontation. This approach discourages some people from participating and may not result in voicing the opinion of the overall community, only those of a few vocal citizens. The traditional format also limits participants to those who have the time to attend, available transportation, and are physically able to participate.

A Web-based approach to public participation can help solve some of the problems mentioned above. The meetings are not restricted by geographical location, and the information about the issues can be attained at any time of day. This method also provides the opportunity to make anonymous comments.

Hyperlinks were used to help users locate themselves on the aerial view maps and photos. This allows a user to click on a street or building and receive information about the item, i.e. name, address, etc. Using an interactive map allows users to obtain the information they need, at their own pace, in order to participate to their fullest extent. In this case study a 1:1000 scale 3D model of a 2-km square area of Slaithwaite and the surrounding valley was constructed. Planning issues of interest for this area included re-opening the canal that runs through the center of the village, and problems arising from commercial traffic and access to industrial sites. Local citizens were then asked to share their concerns and opinions by placing comment flags on the area of their concern. There are five main features to this method:

1. The provision of a large scale model of the chosen area on which the public can place ideas and comments about their community now and in the future;
2. A completely open-ended approach – anything can be said or suggested;
3. It is ideally led from within the community;
4. It is open to all members of the community at a time when most can participate; and
5. It provides information that can be of use to both the local community and the wider local authority in terms of future planning and knowledge of local opinion.

In a system such as this, it is inevitable that there will be conflicts between ideas and opinions.

Slaithwaite is included within the Unitary Development Plan. Many of the focal points of this plan target the more urban areas, causing the citizens who live in rural areas to feel left out. One of the goals of this process was to develop a decision-making process that would involve all citizens affected by the plan. "The lack of public consultation has led to future problems within communities when they are ignored and not asked for their views."

One advantage of the Web-based system used in this case study was that it saved time and money by having the public enter comments straight into the system. This allowed for the system to be constantly updated. Information about errors also allowed the system to be corrected immediately by the operators. The Web-based system allowed the citizens to provide more detailed information about each area of concern than would have been possible on a physical model. Visual images such as photographs and video were not used in this case, but would have provided improved understanding by the public.

After using the system to make comments, the citizens who participated were asked to complete a survey about the process. The majority of the users were male, 70.6%. Occupational information shows that the majority of those who participated were in professional/managerial positions, or in educational fields.

The main problem that arose had to deal with ownership rights of the maps used. This may not be as big a problem in the U.S. Another obstacle may be that it is necessary to have someone with GIS, Internet, and Information Technology (IT) experience to set up this type of system. This may prove to be a problem for smaller agencies, or agencies with a small budget. The public that will eventually use the system should also be considered when developing the system. As IT education becomes more widespread this will become less of an issue, but it should still be considered.

It is important to understand that Web-based systems are meant to enhance the traditional planning process, not replace it. With this in mind, accessibility is still a main concern for Web-based systems. Every citizen will not have personal access to the Internet and the World Wide Web (WWW). The suitability of public access points should be considered before implementing a Web-based system, or else it will not enhance complete community involvement.

It is also important that the users be able to understand the information that is provided. Advances in 3D modeling, and systems that incorporate enhanced photos and hyperlinks help citizens better understand the information they are getting.

Accountability issues are also a concern. It is possible that one group within a community could use a Web-based public participatory GIS to promote their own interests. There need to be effective ways for protecting the interests of the minority. Also the users need to be confident that decision makers will actually use the information that is gained from the public via the Web-based system. If this trust is not there, the public will soon loose interest, if they ever develop it.

Klosterman, Richard E. (1990). Microcomputers in urban and regional planning: lessons from the past, directions for the future. *Computers, Environment, and Urban Systems, 14,* 177-185.

At the time this article was written, Klosterman believed that the electronic spreadsheet was the computer tool with the largest effect on the planning profession. His reasoning for this was that spreadsheets were easy to learn and they provided the necessary tools required to analyze any problem that could be formulated in a two- or three-dimensional table. More importantly, spreadsheets allow decision-makers to evaluate alternative scenarios. Klosterman noted that computer tools for database management, statistical analysis and forecasting, computer-aided design and drafting, and thematic mapping were becoming more important to the planning profession.

Along with these new technologies and the new powers they possess come some problems. The major technical obstacles to computer utilization in planning are rapidly being overcome with the development of powerful and easy to use hardware and software systems, the accumulation of reliable small-area data, and more sophisticated users. As these obstacles ore overcome, problems with the "soft" aspects of technology arise. These include areas such as organization, information, and training.

Klosterman warns that believing new technologies will solve all planning problems is a dangerous way to think. It raises expectations for the new technologies to unrealistic heights, and sets the stage for disappointment, disillusionment, and rejection. With GIS it is important to remember that planning analysis, projection, and evaluation require that GIS capabilities for storing and manipulating geographic data be combined wit planner's models for spatial interaction and prediction. A failure to realize this will cause traditional planning tasks to be neglected for collecting, analyzing, and displaying spatial data on the present.

Klosterman argues that easy to use systems for spreadsheet modeling, database management, and statistical analysis and forecasting increase the chances of using models that are poorly conceived, improperly documented, and computationally incorrect. This also enhances the misuse and abuse of such systems, because the public views computer generated information as more accurate, reliable, and "objective."

The role of these new planning tools in public affairs must be looked at realistically and honestly. The limitations of the information and forecasts must be recognized, and predictions should not be accepted as exact. A range of forecasts should be prepared that identify a range of plausible futures, identify undesirable futures that might occur if ameliorative actions are not taken, and establish and report the error of prediction.

Klosterman states that the effective use of new technologies is often more dependent on organizational and political factors than on technical issues of hardware and software.

Lange, Eckart. (2001). The limits of realism: perceptions of virtual landscapes. *Landscape and Urban Planning, 54 (1-4),* 163-182.

Working in 3D helps the public better understand the work of planners. Planners are not only concerned with the current condition of the land, but also future conditions of the landscape. This will lead to an increasing importance of virtual landscapes in the planning field. This technology allows planners to visualize scenarios or outcomes to alternative plans. These images can then be displayed side by side, making it easy to make comparisons. Due to the hardware, software, data, and time that are required to produce these 3D images, virtual landscapes are still considered a luxury to the planning process. In order for visualization techniques to make a lasting contribution to the field of planning, they need to be utilized in a way that improves communication between planners and those affected by planning.

Essential to this visualization process are data, preferably 3D data. The majority of the data collected in the past is 2D data. The importance of 3D modeling in the future needs to be

recognized now so that proper data collection can begin now. The lack of ready to use data is one of the major obstacles in the spreading of advanced applications in planning practices.

Maier, D., Landis, E., Cushing, J., Frondorf, A., Silberschatz, A., Frame, M., and Schnase, J. L. (Editors). 2001. *Research Directions in Biodiversity and Ecosystem Informatics.* Report of an NSF, USGS, NASA Workshop on Biodiversity and Ecosystem Informatics (NASA Goddard Space Fight Center, June 22-23, 2000, Greenbelt, Maryland). 30 pp.

This booklet describes problems in biodiversity and ecological informatics research and information gathering and sharing, and suggests areas for future research.
The problems discussed here can be associated with many other fields outside of biodiversity and ecology. These problems are very important to the field of planning, because the information that results from scientific research should be used in making decisions, especially land use decisions and conservation decisions.

The first problem this booklet deals with is the acquisition and conversion of data and metadata. This includes digitizing all backlog information, and storing it in a way that makes it easily accessible to those needing it. It is also important to be able to collect, store and transmit data from the field. This would reduce the time for producing new information. It is also important to make sure that all data is consistent. This includes integrating various views, interpretations, and versions of data.

The next problem area is the analysis and synthesis of data and metadata. One focus is on the problem of comparing data at different scales, which can result in the loss of information. The way certain processes are modeled needs to be updated. One of the more important issues is making the data useable. This is especially important in the field of planning. Decision makers need to be able to interpret and understand the data, so they can make decisions based on the information. Metadata also needs to be machine processable. This will help automate data manipulation tasks such as summarization, combination of data sets, and analysis of results. It is also very important that the data and results be accurate and made accessible as fast as possible.

The dissemination of data and metadata is also a very important issue. Visualization can play a large role in this area. Visualization helps people outside the scientific field who will be using this information to better understand it. Another important aspect is interdisciplinary collaboration and communication. It is important that all stakeholders share their information with each other and communicate on the type of data that they need. Guidelines should also be established for the management of this data.

Nadiminti, Raja, Mukhopadhyay, Tridas, and Kriebel, Charles H. (1996). Risk Aversion and the Value of Information. *Decision Support Systems, 16 (3),* 241-154.

The research in this article focuses on the relationship between risk aversion and the value of information. Nadiminti et al. feel this is an important topic because most managers and decision-makers are risk averse rather than risk neutral. In the framework developed by the researchers, the method of payment must be considered when determining this relationship. The Arrow-Pratt measure of risk aversion was used to discover conditions under which the value of information increases with risk aversion.

Nedovic-Budic, Zorica. (2000). Geographic information science implications for urban and regional planning. *Urban and Regional Information Systems Association Journal, 12 (2),* 81-93.

All aspects of the planning process can incorporate geographic information technologies, including data collection and storage, data analysis and presentation, planning and/or policy making, communication with the public and decision makers, and planning and/or policy implementation and administration. Many times the GIS is not used to its full potential. This has been attributed to "the inadequate capacity and structure of planning institutions, which remain unsuited to the new forms and processes required for effective utilization of planning and decision support systems." Additional reasons for underutilizing GIS include the complexity of the technology, the lack of trained staff, the scarce organizational resources, and the fact that generic GIS products do not support the tasks and functions performed by planners.

The following goals of urban and regional planners should be advanced by geographic information science:

- Better quality of urban environments
- Environmentally and socially sustainable communities
- Effective spatial organization of urban activities
- "Smart growth" of urban areas
- Efficient communication between various urban functions
- Revitalization of deteriorated areas
- Variety of housing options
- Employment opportunities and economic development
- Democratization of the planning and policy making process

The following are the areas of advancement in geographic information science that could be of the greatest benefit to urban and regional planners;

1. GIS database developments for planning related analysis,
2. Integration of geospatial technologies with urban models,
3. Building of planning support systems,
4. Facilitating discourse and participation in the planning process, and
5. Evaluation of planning practices and technological impact

The integration of readily available data sets is one way to reduce database development and maintenance time. The scientific input required has been matched up with various stages of the planning process:

- Problem identification requires description and prediction
- Goal setting, plan generation, evaluation of alternatives, and choice of solution requires prescription
- Implementation requires description, prediction, and prescription
- Monitoring requires description and prediction

Planning support systems assist the planning process. Planning support systems (PSS) consist of multiple technologies and common interface. GIS has become an integral part of the PSS. Other features of the PSS can include modeling procedures, expert systems, databases, decision trees, computer aided design, hypertext, mapping, user interfaces for public participation, virtual reality, and the World Wide Web.

The possibilities are there for GIS to improve public access to information and facilitate public participation in the decision-making process. On the other hand, researchers warn of creating a GIS technocratic elite.

Prior to this article, the author has evaluated the impact of GIS on decision-making. The evaluation dimensions that she used included system quality, information quality, information use, user satisfaction, individual impact, organizational performance and societal impact. The

main GIS benefits were perceived to be in information processing. The role of GIS in enhancing decision-making and empowerment has yet to be achieved.

The areas of future research that are the most critical to urban and regional planners are:

- The development of PSS
- Linking of tool developments with planning organizations, process, theory, and methods
- Understanding the impact on the planning process and outcomes
- The visualization of spatial processes and phenomena

The transfer of technology and the incorporation of that technology into the planning process is a challenge directly related to the building of PSS.

Advances in the visualization technologies will enhance the communication capacity of urban planners. However, in order to maximize the potential uses of these technologies they must be incorporated into the planning process.

The policies that would help advance the application of geospatial technologies and tools in urban and regional planning are in the areas of support for development and maintenance of local databases, standardization, access to data, tool building and integration, education and technology transfer, and legal framework.

Nedovic-Budic, Zorica, and Pinto, Jeffrey K. (2000). Information sharing in an interorganizational GIS environment. *Environment and Planning B: Planning and Design, 27,* 455-474.

The increase in the number of agencies and organizations adopting GIS technology has highlighted the fact that there has been a general inability and often unwillingness to share data and information across boundaries. This lack of information exchange among local, state, and federal government and private sector organizations wastes time and resources and hinders the development and utilization of the full potential of the technology.

The Federal National Spatial Data Infrastructure (NSDI) initiative calls for the development of a system that connects government, private sector, and academic institutions that produce and use spatial data. This would allow for unlimited sharing of spatial data and prevent redundancy in developing geographic databases. This could also stimulate interorganizational cooperation and collaboration, resulting in a better information base for management and decision-making. The largest obstacle to achieving this type of system has been coordination among different spatial data producers and users.

A number of agencies do practice the sharing of geographic data. Certain activities have aided this process. The activities include (a) standardization of geographic data formats and contents; (b) metadata creation and standardization; (c) development of clearinghouse nodes; and (d) surveying the needs for and availability of the common basic data sets that cut across local, regional, state, and federal geographies.

This paper is based on a multiple case study conducted to assess the significance of a selected group of organizational and behavioral antecedents and processes that are crucial for sharing and development of GIS databases by various producer and user organizations. Nine significant issues arose that affected the success of the sharing and development of GIS information.

1. Contributions. What would each party be expected to contribute. It was important that this be determined on the front end. The parties were also concerned with the benefits they would receive from this process, such as data, services, equipment, etc.

2. Control. How would the partnership ensure equal control of the GIS, database, and other joint activities? The main disagreement was often the fact that larger agencies wanted an agreement that gave them more control proportional to their size and contributions, while smaller agencies wanted to maintain equal control.
3. Persistence in communication and negotiation. It took a great deal of effort and communication to keep the joint venture in tact. Many times the necessary work to coordinate the agencies took place in informal settings rather than in structured settings. Coalition building, bargaining, and compromise must all be exercised for the success of interorganizational GIS.
4. Differential commitment levels. Some groups were not as committed to the coordination process, some put in extra effort, some became frustrated based on their perception of unequal resource expenditures and returns, and some pushed their on private agendas at the expense of the group. The key to coordinated GIS and database activities is convincing each member organization of the important synergies that derive from a long-term commitment to the sharing arrangement, both for the sake of the data and future collaborations at all levels between the organizations.
5. Authority and stability in project leadership.
6. Database responsibilities. Who would be responsible for developing and maintaining the geographic information? To what degree would each partner be responsible for sharing the costs of data acquisition, data entry, and maintenance? The most successful relationships are those that specifically state these responsibilities.
7. Data ownership. Who would possess the data? Participants associated location of the data with control.
8. Data access. How would equal access be ensured to all parties? The sharing structure should be indicated early in the process. It is also important to maintain proprietary data outside the core database.
9. Technological/organizational change. Organizational change must take place as new technologies are introduced. Organizational actors who foresee and correctly anticipate the changes required are more likely to implement successfully their data sharing arrangements than those who do not foresee such changes.

Benefits of the interorganizational GIS included consistency in formats and map base, enhanced organizational cooperation, and GIS diffusion to small jurisdictions. The major difficulties cited by participants were the problems of meeting equipment specifications, data standards, implementation time, and financial obligations.

Management is often viewed as the most important success factor in enterprise GIS solutions.

Osleeb, Jeffrey P., and Kahn, Sami. (1999). Integration of geographic information. Virginia H. Dale and Mary R. English (Editors), *Tools to Aid Environmental Decision Making*. New York: Springer. 161-189.

The information that is required for decision-making comes from many sources and in many forms. The key to integrating information is finding a suitable format to tie the information together. Many geographical and environmental data has a spatial component, but the data is often stored in tabular form, this makes the information more difficult to interpret. To maximize the use of this spatial data, it must be linked with other spatial and non-spatial data sets. Osleeb and Kahn discuss three techniques and applications for the integration of such data: GIS, spatial decision-support systems, and Geographic plume analysis.

The greatest strengths of GIS are
- Presentation of spatial information in a visual manner

- Accumulation of information from various sources and the representation of all that information in the same geographic scale
- Allowing one to point to a location on a map and obtain information about that location
- Ability to perform spatial analysis on a site to determine its impact on other locations

One drawback to GIS is that it can be expensive, and it requires trained operators to produce meaningful analysis. GIS can only be used effectively if it is properly integrated into the entire decision-making process. GIS is only as good as the data put into it. The information should be as current and as accurate as possible. It is possible to perform inaccurate analysis with GIS if the information is misused, either intentionally or accidentally.

A spatial decision-support system (SDSS) is a specialized application of GIS that merges that technology with powerful mathematical models. This is useful in creating scenarios for alternatives. This system also allows the cost of solving the problem to be evaluated and compared to the cost of leaving the problem unresolved. One advantage of SDSS is that it has limited data requirements. These systems can also increase public participation in the decision-making process and help them to better understand decisions that are made. SDSS allow citizens to propose alternative solutions to a problem, then the alternative is evaluated by the SDSS and the citizens can see how there suggestion compares to other alternatives.

Geographic plume analysis (GPA) is another specialized application of GIS. GPA allows decision-makers to overlay the results of air-dispersion models with census information to estimate the demographic impacts of releases of toxic substances. The strength of a GPA is the ability to predict the effects on a population of specific concentrations of substances at various distances from a point source or from several sources.

Information about the history of data used in GIS has become necessary. This information is called metadata. Metadata identifies the availability of data, the agency source of the data, the format of the data the cycle of data collection, and the nature of the data in their present form.

Paul, William George. Jackson Ward Electronic Community Project: Politics, Participation, and the Internet; Richmond, VA. *Online Planning Journal.*
http://www.casa.ucl.ac.uk/planning/articles41/jacksonward.htm

Technology provides planners with a new way to engage in discussions about related issues. New technology can be used to provide images and detailed information that can help everyone to better understand the built environment and the effects it has on the population. The Jackson Ward Electronic Community (JWEC) was designed to be a step in this direction.

Jackson Ward is a minority community with high unemployment and low to moderate education levels. Very few people in this community had computers in their home and public access sites were limited. This project was an attempt to increase awareness of the key issues and needs of Jackson Ward by creating a web site about the community and getting input from the people who live there. Another goal was to give the residents of Jackson Ward an equal voice in the community participation role of the planning process. The web site was to use a collection of images, databases, and processes accurately describe the neighborhood, and at the same time test the ability to collect, format, and disseminate information on the Internet. One final goal of the project was to coordinate and unify community groups and citizens on Jackson Ward.

In addition to the web site, the JWEC project included e-mail, online registrations, a virtual tour, an aerial photograph, a glossary of terms, web resources, visions for the neighborhood, as well as a chat and discussion archive tool and scripts. The virtual tour sparked the most discussion. Most of the discussion revolved around the images used in the tour. Some wanted less "negative" images, while others appreciated the balance shown. The aerial

photograph could have been easier to understand and relate to by clearly identifying specific buildings and streets. The chat and discussion archive tool was easy to set up, and was considered a success.

Overall, the project did not meet the desired goals. This can be traced to two major issues; access and computer skills. If you invest in the hardware and software without teaching the intended users how to use it, or without even making sure they will have the opportunity to use the system, you will end up with an underutilized tool. Because there is a lack of computer access and user skills in Jackson Ward, the researchers realized they might have had more success by communicating through "multiple, face-to-face meetings at the block level and through flyers and park socials."

Rybaczuk, K. Y. (2001). GIS as an aid to environmental management and community participation in the Negril Watershed, Jamaica. *Computers, Environment, and Urban Systems, 25 (2),* 141-165.

The Negril Watershed ecosystems are under great pressure due to the tourist-based development that has occurred in the area. Initially, the GIS was developed to assist in carrying out functions of the environmental plan for the Negril Watershed such as environmental monitoring and management. The role of the GIS was expanded to enhance community participation and collaboration since environmental protection was approached as a community initiative.

One of the primary goals for the GIS was to integrate a wide range of information sources held by different agencies in various formats. A second goal for the GIS was to improve spatial representation in order to better record features such as coral reef buoys for baseline studies. Another goal was that the GIS would have an active role in the scientific management, analysis, and modeling of the environmental aspects of the watershed. A final goal was that the GIS would allow some theme to be viewed in a spatial context for the first time, i.e. census information. More importantly, it was believed that the visualization capacities of the GIS would improve communication for both the scientific community and the local community by facilitating information flows within each community group and between groups. Plans were also made to evaluate the role of GIS in enhancing the community's involvement in plan development, and whether or not this technology would increase community participation in environmental management and conservation.

The GIS succeeded in providing the technical information desired. Whether or not GIS enhanced public participation and understanding is not so clear. Currently, only one particular sector of the community is represented on the Negril Environmental Protection Trust, meaning that more marginalized sectors of the community are under-represented and less involved. Locals have been involved in the distribution of information and have provided manual labor, but have not been involved in local analysis, discussions, and joint planning.

This article suggests improvements in four areas to extend GIS beyond simply offering selected representatives of the community cartographic output. The four areas are: (1) extending the information type; (2) extending the method of data collection; (3) extending the access to GIS results and GIS technology; and (4) extending the consultative and participatory process.

Extending the information type means that information needs to be made available in a format that all citizens can understand. Less formal means of conveying information such as photographs, stories, and artwork need to be integrated with data that are more formal.

Extending the method of data collection means that local citizens need to be involved in the data collecting, not just outside "experts." This provides an excellent opportunity to involve those citizens who have been excluded, either socially or economically.

Extending the access to GIS results and GIS technology depends heavily on infrastructure and money. In areas where this cannot be easily achieved it is important to train local community development officers in GIS technology so that it does not remain solely in the hands of the scientists.

Extending the consultative and participatory process is more of a political problem rather than technical. An adequate community-based network must be fully established or else the information gained from the technology will remain in the same social circles.

Shiffer, Michael J. (1992). Towards a Collaborative Planning System. *Environment and Planning B: Planning and Design, 19,* 709-722.

The quality of plans and decisions depends heavily on the amount and quality of relevant information used in the decision-making process. The quality of the final plan or decision also depends on the level of communication amongst participants in the decision-making process. Shiffer discusses a Collaborative Planning System (CPS) that helps improve both of these areas of the planning process. This microcomputer based CPS combines graphical interfaces, associative information structuring, and computer-supported collaborative work.

Graphical interface refers to the tools used to make forecasts and models easier to create and understand. The technical nature of forecasting and modeling tools usually causes less technically oriented people to be excluded from the planning process. Graphical interface tools make entering data much simpler by allowing users to point to maps, or slide graphs instead of having to memorize computer codes. Graphical interfaces also improve the understanding of the results by presenting them in forms less technical and more image-based. These tools also improve understanding through enabling the user to view the information in several different contexts. For example, the effects of a proposed bus station on the land values of the surrounding neighborhood could be expressed in one chart, shifts in demographics in another, and a video display could be used to show physical changes.

The CPS incorporates hypermedia technology. This allows planners or decision-makers to combine planning related material such as maps, written documents, statistical data, video, etc. into a format that allows for immediate cross referencing of a number of concepts. The information is organized by association.

The development of a CPS begins by defining the problem area. One example of this was the St. Louis Riverfront CPS used for redevelopment along the city's waterfront. The better defined the area is the less time will be wasted on collecting useless information. The St. Louis CPS began with a video navigator that allowed the user to "fly" up and down the waterfront while the matching location was highlighted on a map. Next, an information based was added that consisted of: "site specific descriptions of potential development, area businesses and industries, residential developments, recreational areas, environmental impacts, past proposals, and general plans."

Shiffer draws three major conclusions about CPS in this article. The first is that it takes time for a hypermedia system to reach its full potential. The system improves over time as users become more familiar with it, and as links and relationships among the data are built. Shiffer also states that it is necessary to study human interaction with these systems more closely before the full impacts of CPS on the planning process can be evaluated. The final conclusion is that CPS will improve access to relevant information and lead to improvement in the quality of plans, increase the number of alternatives created, and improve the quality of final decisions.

Shiffer, M. J. (1995 a). Environmental Review with Hypermedia Systems. *Environment and Planning B: Planning and Design, 22,* 359-372.

The hypermedia system discussed in this article organizes information such as documents, images, and analytical tool outputs in an associative form. The system also provides the capabilities for "real time" updating of maps with text, graphics, audio, and/ or video. A third characteristic of the system is that it uses descriptive images such as digital video to aid in the presentation of quantitative information. Shiffer explores the capabilities of this system in an environmental review process. A hypermedia system is incorporated into the process of developing reuse scenarios for an Air Force base.

Shiffer focuses on the types of information typically used in planning meetings, how this information is communicated, and what, if any, affect the technology has on the process. He also discusses steps to enhance user acceptance of this technology.

Shiffer, M. J. (1995 b). Interactive Multimedia Planning Support: Moving from Stand-Alone Systems to the World Wide Web. *Environment and Planning B: Planning and Design, 22,* 649-664.

In this article Shiffer again discusses Collaborative Planning Systems that incorporate hypermedia systems. Most of the introductory information in this article was covered in Shiffer (1995 b). However he does bring up a couple of different points. The first is that it is important for the institution with this type of system to provide the infrastructure necessary to maintain or update the tools. Neglecting to do this could lead to a lack of access to information that changes rapidly.

Another interesting point he makes deals with how quick links can be added to the site. If links cannot be added instantaneously during group discussions, a delay will occur. This is not a serious problem during small group meetings, but during meetings with larger numbers of participants this could be a distraction. Shiffer goes on to say that these distractions could eventually decrease user confidence in these tools and result in the downfall of such technological assistance.

Tonn, Bruce, Turner, Robert, Mechling, Jerry, Fletcher, Thomas, and Barg, Scott. (1999). Environmental Decision-Making and Information Technology: Issues Assessment. *Oak Ridge National Laboratory, ORNL/NCEDR-9.* 31pp.

This report summarizes a workshop held at Harvard University in October of 1998. The report is divided into four sections. The first section summarizes presentations given on current uses of information technology (IT) in environmental decision-making and the state-of-the-art technology in the field. The second section discusses some general concerns raised during the presentations of the current uses. The third part presents the results of a survey taken during the workshop. The goal of this survey was to identify the areas of IT that could offer the most benefits to the field of environmental decision-making and the areas that needed the most improvement. The final section of the report recommends future actions on this topic.

The discussion about current IT uses in the field of environmental decision-making confirmed that technologies such as geographical information systems (GIS) were being used to support final decisions. Different forms of IT were also being used to improve access to data and to promote cooperation among different organizations.

How to build flexible information systems was one of the concerns mentioned during the second part of the report. This discussion revealed that most systems are not easily changed in a short amount of time, and not very cheaply. The discussion then focused on a risk-based model to guide system development. This model included eight elements: risk identification, risk

assessment, prioritization, definition, disaggregation, resource allocation, action planning, and implement, monitor, and evaluate.

The quality of data available to support science and policy analysis was another concern of workshop attendees. The attendees were also concerned with how the public would react to incorrect or insufficient data. There are many possible flaws that can affect the quality of data, such as the data may be out of date, or the history of the data may be weak or not understandable. One topic of discussion was whether or not to limit the data made available or to make it all available and explain the quality.

Another concern was matching organizational structures with the capabilities of information technology to benefit environmental decision-making. This is a difficult task. One suggestion was to allow frequent comments on the development of the system and regular reassessment of the match between the user needs and the system qualities.

The workshop survey was used to find out which areas of environmental decision-making were the most focused on, and which areas were believed to be the most important. The areas agencies seemed to be focusing on the most were: GIS and visualization tools, the Internet, data warehousing, and data standards. Developing decision support systems was among the areas of least activity. The areas that were believed to be the most important were: the Internet, communication and education, community-based decision-making, and GIS and visualization tools.

Future actions concerning IT and environmental decision-making were the focus of the last section of the report. One of the suggested next steps dealt with moving environmental decision-making to the community level. This also included making these community-based systems available to all members of the community. Attendees believed that future research should focus on user interface designs, cultural reactions to community—based systems, communicating data quality and uncertainties about choices based on this data.

Thomson, Curtis N., and Hardin, Perry. (2000). Remote sensing/GIS integration to identify potential low-income housing sites. *Cities, 17 (2),* 97-109.

When suitable data are appropriately and efficiently handled, planning and decision-making can be greatly improved. This paper looks at how satellite imagery can act as a medium to generate a number of GIS coverages and how it can provide site-specific information on land cover for mapping urban residential land use.

A number of spatial information technology systems are becoming integrated within a GIS environment. Among these technologies are digital imaging, remote sensing and photogrammetry, object recognition, environmental modeling, and artificial intelligence. GIS can perform many functions in a supporting role for informal settlement analysis. Some inherent tasks include access to transport linkages, to employment, and to services. The practical success of such GIS depends on collection systems that can provide geo-spatial data at a low cost, and then convert this information into low-cost, easy to use GIS databases appropriate for decision-making at the community level, and the awareness and capacity of participants to support the GIS.

One of the major advantages of GIS to urban planning is that a combination of digital map and database information allows for great flexibility in assessing alternative scenarios. However, compiling an urban GIS is time consuming and expensive. Constructing the database information associated with the maps is one of the major costs. Approximately 80% of time and costs go toward acquiring and integrating the databases.

Remote sensing has become an important source for GIS data. This technique allows for more current and accurate data. Remote sensing is beneficial for land cover analysis. Using this information in a GIS helpful because it provides the data in a digital format and eliminates the

need for manual analysis that can be costly and inaccurate. A truly operational GIS for planning purposes requires the integration and automation of at least some of the basic procedures in both remote sensing and GIS. One problem with this source of data is that extracting land cover information acquired through remote sensing is often at too small of a scale for some planning tasks. This method is useful for performing applications at medium to small scales (1:20,000 or smaller). This can still support a variety of urban GIS projects.

Satellite data is also an important source for studying urban environments. This method provides valuable and timely information for interpreting the landscape.

In the planning field there are three major tasks involved in converting raw geographical data into a finished land use map: input of data, data analysis, and output results.

The integration of remote sensing and GIS has been used to study urban climate, urban environment and quality of life, and housing.

Planning Process

Ehrmann, John R., and Stinson, Barbara L. (2001). Joint fact-finding and the use of technical experts. *Chapter 9 in forthcoming book,* Meridian Institute. 28 pp.

This paper discusses how organizations and stakeholders can use joint fact-finding and the use of technical experts to work towards an agreement on an issue. In joint fact-finding, stakeholders with different interests and viewpoints work together to develop data and information, analyze facts and forecasts, develop common assumptions and informed opinion, and use this information to reach a decision together.

Many times in decision-making processes each side will bring in technical experts that support their side of the argument. This can be an expensive process, and rarely accomplishes anything since the experts rule each other out. This does not make this information less valuable, it suggests that the manner in which the information is gathered is as important as the information itself. In joint fact-finding the stakeholders should jointly determine the issues that require technical analysis; the questions that the experts should research; which expert to use; the best process for gathering and answering questions; the limitations of the various analytical methods that will be used; and the best way of proceeding once a scientific or technical analysis is completed.

Joint fact-finding has many potential benefits. This process can address information gaps and scientific uncertainty. The participants in this process also have an opportunity to learn about the scientific underpinnings of various arguments. Joint fact-finding can produce agreements that are more credible, more creative, and more durable. If all stakeholders play a part in gathering and assessing the information on which the decision is based, then they are more likely to stick to that agreement. This process also allows each stakeholder to learn more about the other stakeholders needs and interests, and can form stronger relationships among them.

There are five steps in the joint fact-finding process described in this paper:
1. Determine the issues of concern that require further information
2. Determine a process for gathering information and answering key questions
3. Determine the questions to be asked and the method of analysis to be used
4. Determine any limitations on the analytical methods to be used
5. Determine the best ways of proceeding once new information is available

The first step in this process should be to define the "problem" or issue to be resolved. Then the stakeholders should identify the most crucial information gaps or uncertainties that exist and the issues that could be appropriately pursued in a fact-finding process. It is also very important that all areas of concern are identified at the outset.

The participants should then determine ground rules for information gathering and analysis, who will manage the process, which expert(s) to use, confidentiality needs and reporting requirements, as well as begin discussions on how the information will be used to reach a final decision.

If an expert is used, the stakeholders should decide on how he/she will report back to the group and how often the expert should give an interim report. Interim reports are important to ensure that the results will be acceptable to the entire group. Regardless of the method used to obtain information, whether it is through an expert or by other means, the stakeholders should be familiar with limitations of statistical analysis, i.e. margin of error, and how that can invalidate the results.

Once all the information is collected, all the participants should receive the final results at the same time. It may be necessary to develop contingent agreements based on several potential options, if one option does not clearly emerge as the appropriate basis for agreement.

The success of this technique depends on whether the information produced is adequately integrated into the joint decision-making process.

Hoch, Charles J., Linda C. Dalton, and Frank S. So. 2000. *The Practice of Local Government Planning, Third Edition.* International City/County Management Association. Washington D. C. 19-57.

In addition to describing the current behavior for a city or region, a planner should also anticipate behavioral changes and their consequences. Hoch et al discuss approaches to developing plans that achieve this goal. Included in this discussion is how planners have adapted the rational model of decision-making.

Creating a plan for a community, city, or region involves dealing with people from institutions of commerce, community, and government that all follow their own rules, taking the actions of others for granted until something goes wrong. This provides an excellent opportunity for modern technology to be put to use in a way that will promote and increase communication and information sharing between all stakeholders in the planning process. Plans are more likely to be implemented when they are based on shared beliefs – especially beliefs that are acquired through efforts to build consensus.

Professional planners "use a rational decision-making model that adapts a version of scientific inquiry as a guide for decision making." This model follows four steps:
- Define the goals,
- Identify the problems that frustrate fulfillment of these goals,
- Identify alternative solutions to the problem that will achieve these goals, and
- Compare each alternative as a solution to the problem.

Planning theorists have developed three alternatives that expand this model to better explain how to guide public decisions: comprehensive planning, policy planning, and consensus building.

The first model below, Model 1, is how the traditional process is expanded and applied to a comprehensive planning approach. This approach to planning requires that planners work closely with residents and other professionals to identify and describe community characteristics, articulate goals, and explore alternative plans for the future.
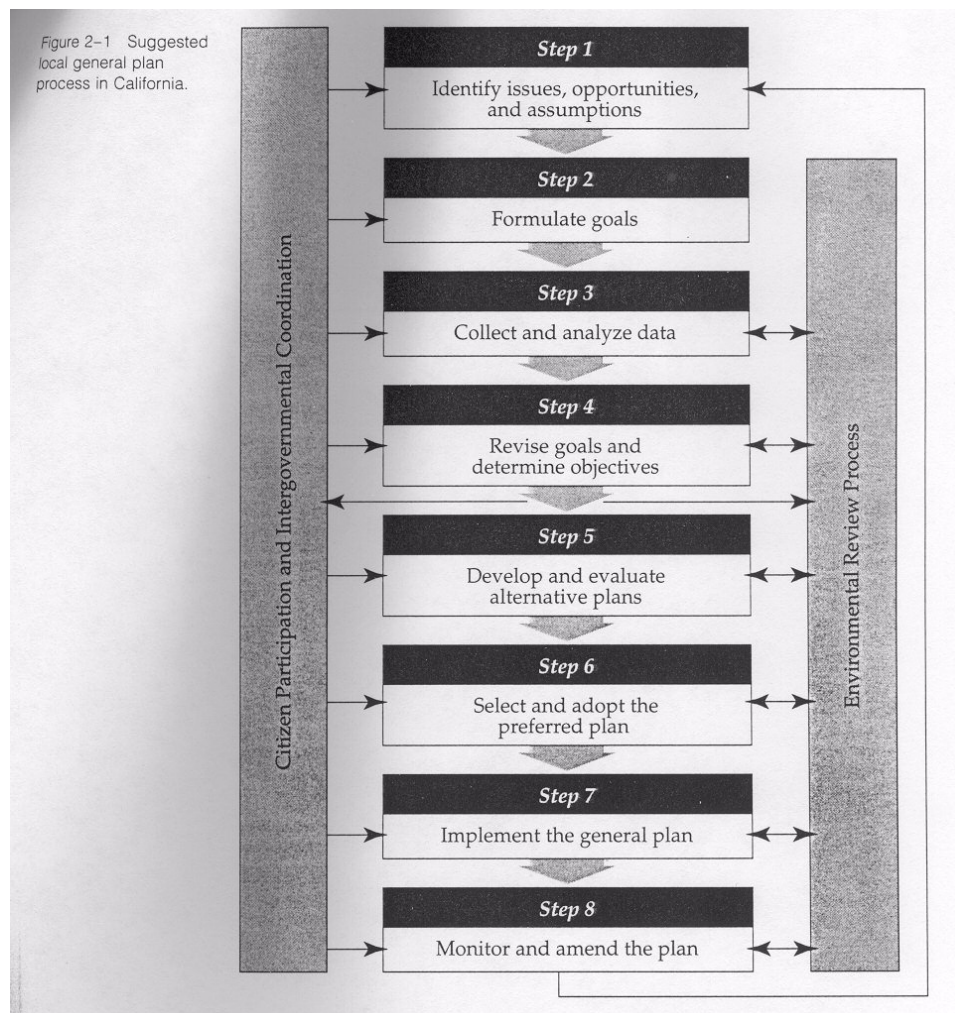
The policy planning approach is a process that does not focus on land use and site design but on the relationship between goals, policy making, and social consequences. This approach encourages extensive involvement from a variety of local residents, activists, politicians,

administrators, NGOs, and other groups whose absence would undermine the legitimacy of the policies that might ensue.

The following model, Model 2, illustrates the strategic community planning approach. Strategic planning reaches out to explore a wide variety of policies and strategies that benefit the community. One addition to this model is the environmental scan, which includes a "SWOT" analysis. A SWOT analysis addresses the Opportunities and Threats that are most likely to affect the future of the community, and the Strengths and Weaknesses the community possesses to deal with them. This process also includes identifying the relevant groups willing to participate in the planning process. This model represents a streamlined approach to "rational decision making that focuses attention on improving ways to cope with environmental uncertainties that hamper the goals of a firm."

The consensus theory of planning focuses on the rational integration of diverse goals through shared deliberations instead of on the rational analysis of causes, interests, or strategies.

"Planners may use the best technical data and draw upon the latest theories when they organize planning studies, but they use the concerns of particular officials, interest groups, and other stakeholders to focus inquiry, select data, organize analysis, and construct the alternatives that shape the comprehensive plan."

Figure 2–1 Suggested local general plan process in California.

Citizen Participation and Intergovernmental Coordination

Environmental Review Process

Step 1 — Identify issues, opportunities, and assumptions

Step 2 — Formulate goals

Step 3 — Collect and analyze data

Step 4 — Revise goals and determine objectives

Step 5 — Develop and evaluate alternative plans

Step 6 — Select and adopt the preferred plan

Step 7 — Implement the general plan

Step 8 — Monitor and amend the plan

Model 1: Rational-Decision Making Model for Developing a Comprehensive Plan

It is important that site plans and comprehensive plans do not conflict with each other. It is important that comprehensive plans include site plans because the characteristics of the land, buildings, infrastructure, and inhabitants at a specific site can pose both opportunities and limitations for the development of that site. Failure to include site plans could also be a missed opportunity to provide guidance for local efforts to remedy a regional problem. It is as equally important for the site plans to be developed within the broader framework of the comprehensive plan so that they are not at risk with larger systems, such as sewers, air quality, housing markets, etc., or so they are not imposing unexpected burdens on neighboring places.

The creation of alternatives goes beyond rational analysis. It requires the imaginative consolidation of diverse goals into a more direct plan of action the people might take. This step may lead to revisions of the goal, or its meaning, once certain outcomes and consequences are displayed from following a proposed plan of action. GIS technology and 3D imaging can be very useful in this process. This technology allows the results of certain actions or non-actions to be seen. In the case of the Tennessee River Gorge Project, scenes of the river gorge can be created to visualize the possibility of future development if no restrictions are put in place. A scene can also be created for what the river gorge would look like with protective measures put in place.
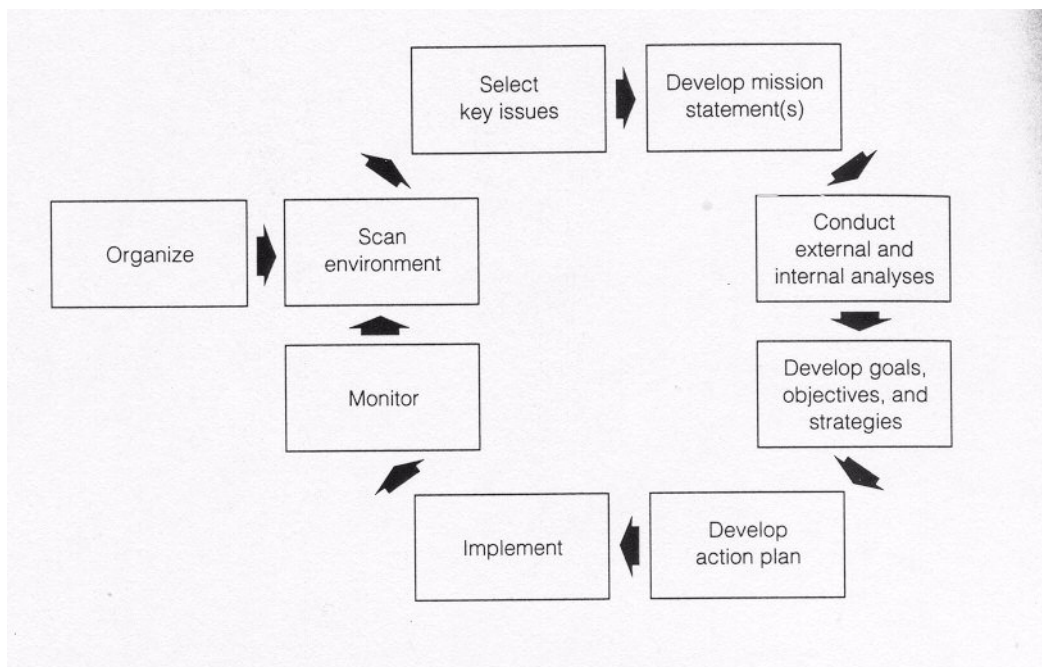

Model 2: Strategic Community Planning Model

The backbone of good planning is described as, "thoughtful problem identification, informed analysis, and fair-minded evaluation and choice of options."
Evaluation determines whether or not a plan meets these criteria. Four guidelines are offered to evaluate a plan:
1. The plan works that improves acceptance of an alternative.
2. A plan works that inspires people to follow its objectives.
3. A plan works that meets a wider public interest.
4. A plan works that meets the expectations of planning colleagues.

Smith, Guy-Harlod. 1971. *Conservation of Natural Resources, Fourth Edition.* John Wiley and Sons, Inc. 624-634.

This article includes the simplified model of the planning process shown below. This illustrates that planning is a circular process, and is never truly completed. There can also be links between the analysis step and the goals step. After analysis of the collected information (inventory), the goals may have to be modified. There may also be another link between implementation and the creation of the plan. Some aspects of the plan may have to be changed before a complete evaluation can be performed, or it may not be possible to implement some parts of the plan at all.

This article recognizes the city and regional planning process as an attempt to improve the quality of the environment. It also recognizes that planning must continue to evolve in order to meet the changes in human desires, technology, and population increases. Planning for natural resources, and planning in general, can be approached in a way to conserve and develop natural resources upon which the future well-being and existence of the community are dependent, and take immediate steps to prevent undue depletion or pollution of these resources.

The planning process

Goals

Evaluation   Inventory

Implementation   Analysis
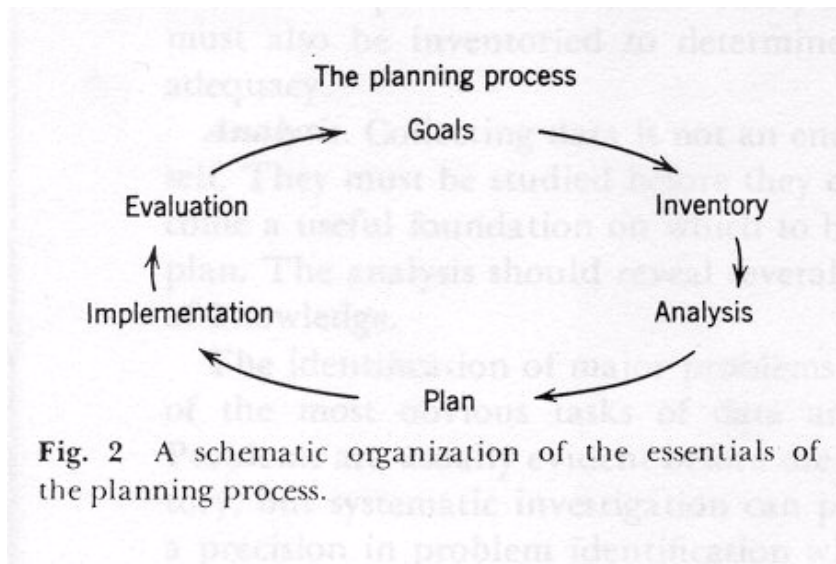
Plan

Fig. 2 A schematic organization of the essentials of the planning process.

After establishing the goals of the community, an inventory of existing conditions must be made. Much of this information can be presented in map form. This provides an excellent opportunity for the application of advances in technology, especially GIS and 3D imaging. This type of information includes physical data such as soil classifications, topography, vegetation patterns, streams, and floodplains; environmental uses such as land uses, street locations, and building conditions; and public facilities such as parks, schools, firehouses, public utilities, and police stations.

This data must then be studied. Again, technology can play an important role in this process. Technology can aid in presenting the information in a way that decision makers and planners can better understand it, and therefore make better decisions based on this information. Not only can technological advances be used to discover problems, but also in finding the cause of these problems. To best determine future needs, this step of the process needs to be revised as soon as new information becomes available.

A comprehensive plan includes three elements: a land-use plan, a transportation plan, and a public facilities plan. All three of these are interdependent. A change in one can have an effect on the others. In the urban setting the land use plan delegates areas for housing, industry,

shopping, etc. In a regional scope, this plan focuses on forests, prime cropland, potential mining areas, etc. The land use plan should insure that land is used for purposes that it is best suited.

The transportation plan includes the placement of streets and highways. While many features of a city may change over time, streets often remain in the same location for centuries. Community facilities can be greatly enhanced if they are coordinated with land uses and the transportation system.

This article mentions a technique that some cities have used in order to preserve certain land uses; leaseback and/or resale arrangements. Cities acquire open land, then lease or sell the land back to individuals with the provision that the land continue to be used for agriculture, forestry, or other approved usages. For resource conservation plans or any comprehensive plan to be successful, the plan must receive public support. Technology could also help present the information in a way the public can understand the benefits of the plan.

Evaluating Technology for Planning Use

Bastian, Olaf. (2000). Landscape classification in Saxony (Germany) – a tool for holistic regional planning. *Landscape and Urban Planning, 50 (1-3),* 145-155.

For this study in Saxony, Germany, the entire state's landscape was classified from a physico-geographical point of view. With the aid of GIS, landscape units were mapped, described, classified, documented and processed for a computer-based inquiry system. A new methodology was created to assess the suitability of natural landscape units for human activities, the functioning of natural balance, and the carrying capacity. This new methodology also incorporated drafting the regionalized goals of landscape management.
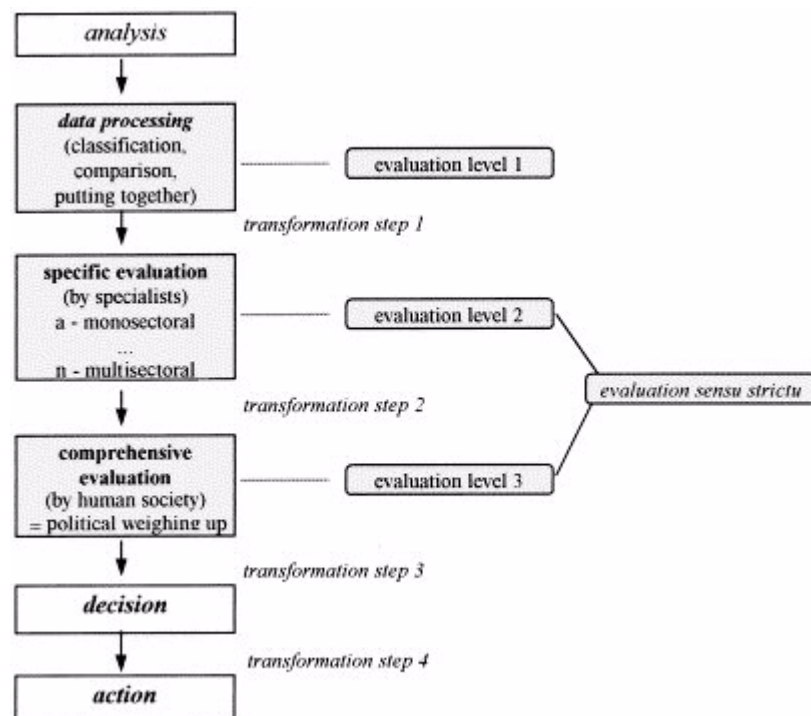
The new methodology expands on an existing approach that is based on smaller reference units. This is beneficial to drafting goals for future landscape development considering both social and ecological aspects in a holistic manner.

"The mapping of landscape-ecological units and their characterization, classification, and assessment can play an important role as basic information and provide reference units for landscape visions in planning processes on regional scales."

This process and the evaluation of the information are important because scientists can propose environmental goals, but political decisions are necessary for them to actually occur. Land evaluation, including landscape function and natural potentials, is an important step to transform scientific knowledge to social categories. If ecological analysis and other research are used in the planning process, the data must be evaluated. Evaluation is the critical step to process analytical data concerning decision-making and action, such as converting scientific parameters into socio-political categories. "Ecological facts, effects, and context are translated to parameters which are relevant to human society in order to draft goals and political decisions.

This paper provides the above model for evaluation procedures on different levels. "This is the basis of decision-making and, ultimately, of concrete actions."

The methodology begins with the assessment of landscape functions. Then actual and potential threats are identified. Next, based on the characteristics of individual landscape units and the assessment of landscape functions and goals, targets for single landscape factors/functions are drafted. Integration is critical for making partly incongruent goals consistent with each other. With respect to the evaluation model above, this corresponds to level 2, because – initially – only specialists were involved in the decision-making process.

This methodology is a promising attempt to introduce landscape-ecological facts into the regional planning practice, and to bridge the gap between natural sciences and economical interests of human society.

Budic, Zorica D. (1994). Effectiveness of geographic information systems in local planning. *Journal of the American Planning Association, 60 (2),* 244-263.

In this paper Zorica Budic uses a survey of local governments in four southeastern states to study how GIS affects planning and whether it meets the expectations of the planning agencies using it. The effectiveness of GIS is considered in two realms:

1. Improvements in the quality and quantity of planning related data (operational effectiveness), and
2. Facilitation of planning related decision-making (decision-making effectiveness).

This study uses seven factors that may affect the success of GIS implementation to study both types of GIS effectiveness:

1. Political support for incorporation of GIS technology
2. Staff support for implementation of GIS technology
3. Length of time that GIS technology has been utilized, reflecting experience with the technology
4. System sharing (multi-departmental versus single department GIS set up)
5. Comprehensiveness of the GIS database, i.e. the number of maps (data layers) it contains
6. number of applications for which GIS technology is used
7. Type of tasks performed with GIS technology (routine operations versus data analysis and/or synthesis)

The methodology used for evaluating effectiveness consists of four levels: (1) operational efficiency; (2) operational effectiveness; (3) program effectiveness; and (4) contribution to well being.

One important note to mention is that this research views the benefit of GIS technology as an improved decision-making process, not better decisions. It does not assume that improved information leads to better decisions.

This study examines the change in quality of operational and decision-making effectiveness by comparing the state before and after and agency used GIS. The indicators used to define operational effectiveness were:

- Accuracy of positional and attribute data
- Availability of current data
- Data collection time, including sources other than the GIS database
- Accessibility of maps and tabular data contained in the GIS

Indicators used to define decision-making effectiveness were:

- Time needed to make decisions
- Explicitness of decisions
- Identification and clarification of conflicts
- Communication and interpretation of information
- Confidence in analyses generated with the GIS

The survey was directed at the department head or the staff member most familiar with a particular GIS. The results of the study are based on the GIS user's perceptions. 22 surveys were used to perform the data analysis.

The research shows that the GIS technology met the expectations of the agencies that have been working with it long enough to judge the benefits. Widely observed operational effectiveness benefits included data accessibility, data accuracy, and data availability. Widely observed decision-making benefits included communication of information and the confidence in analyses performed with a GIS.

Calkins, Hugh W., and Obermeyer, Nancy J. (1991). Taxonomy for surveying the use and value of geographical information. *International Journal of Geographical Information Systems, 5 (3),* 341-351.

This paper describes a series of questions, or taxonomy, to be used in evaluating the use of geographical information, regardless of the technology used to provide the information. The focus of this paper is on how this geographical information and analysis is used in decision-making. As interest in GIS has grown, so has the need for a more effective communication of ideas, experiences, and potential applications among GIS users. Precise definitions and formalized structures have become necessary.
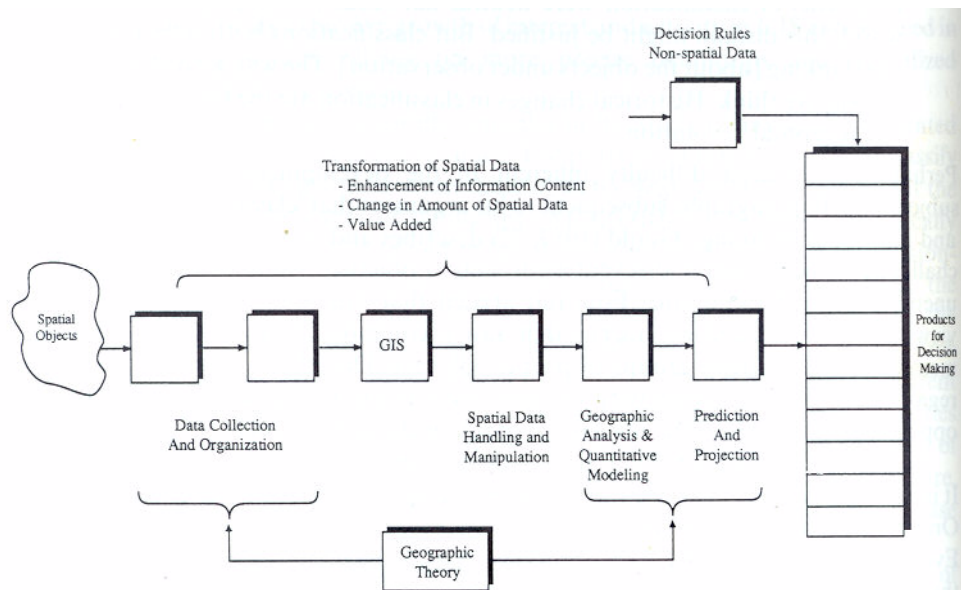
Figure 1.   Organizational use of geographical information for decision making.

This model shows how GIS fits into the process of providing information to decision-makers. GIS is to transform the collected data into a useable form for decision-makers. The components of the taxonomy are based on 3 key questions:

1. What successful uses are being made of geographical information, successful being defined as use that creates benefits?
2. How effective is the use of geographical information?
3. What are the benefits attributable to the successful use of geographical information?

Two additional categories of questions are also of interest:

1. What characteristics of geographical information processing are associated with successful use?
2. What organizational factors are associated with successful use?

The taxonomy given here consists of 24 questions, which have been broken down into 6 sections:

1. Characteristics of successful uses of geographical information
2. How effective is the use of geographical information?
3. What are the benefits of the use of geographical information?
4. Measurement of benefits
5. Characteristics of geographical data and spatial analysis
6. Organizational factors

Testing this taxonomy is a three-step process. The first step is to build a suitable survey instrument. The second step involves verifying the availability of users to supply answers to the survey questions. The third and final step is to determine the appropriate universe for continuing surveys.

Using GIS and other information technology to provide geographical information can be expensive. The need for this information needs to be justified economically and in overall value to society. This taxonomy can be used to help determine the value of this information.

Campbell, Heather. (1994). How effective are GIS in practice? A case study of British local government. *International Journal of Geographical Information Systems, 8 (3),* 309-325.

This article looks at how well organizations in British governments have implemented and adapted to GIS. Campbell evaluated the GIS of 12 government organizations. The evaluation consisted of 2 parts. The first part indicates the limited impact GIS has had on the local authorities studied, even after at least two years experience. The second part of the evaluation tries to identify the issues responsible for inhibiting the effective implementation of GIS in these organizations.

The success of a GIS depends not only on the necessary technology, but also on relating it to the organizational contexts into which it is to be implemented. This study focuses on implementation. Implementation is considered an on-going process of repeated cycles of learning, development, and utilization. Long-term impacts of GIS must take into account the diversity of applications that ranges from simple map-making facilities to more complex systems for supporting managerial and strategic decision-making. Each of theses systems will have their own needs and characteristics.

A comprehensive phone survey was conducted for all 514 local authorities in Great Britain. This allowed the researchers to get an overview of the state of the art in GIS development in Britain. Twelve case studies were then used to supplement this information. It is important that the case studies be structured in a way so that the researcher gets behind the formal appearance of the activities of the organization and the individuals of which they consist. The case study should also include interviews with a wide range of people including direct users, potential users, and all levels of management.
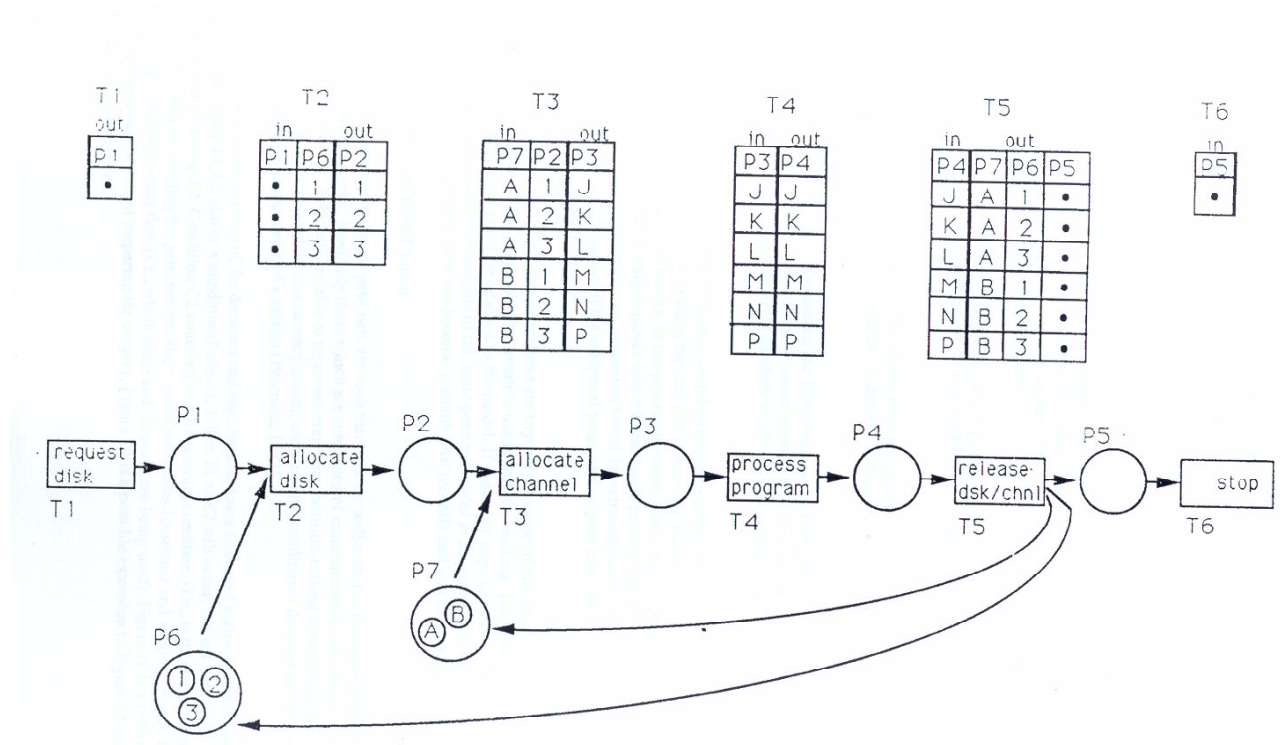
The case studies found that the GIS systems were being used for operational activities, regardless of whether more sophisticated actions were possible within the software. The GIS also tended to focus on the needs of one department, even though several departments used the same software. Another problem was that very few of the organizations had complete data sets or data that was in a suitable format for input.

Dickinson, Holly J. (1990). Deriving a method for evaluating the use of geographic information in decision-making. *National Center for Geographic Information and Analysis Report 90-3,* State University of New York at Buffalo.

The objective of this research was to demonstrate (through an in depth case study) that the use of geographic information and its analysis could be modeled in sufficient detail to permit the identification of costs and benefits attached to all or part of the decision-making process. Many methods were reviewed to find the methods that supported the economic evaluation of a GIS implementation. The methods review concluded that methods for determining the value of information are not practical for evaluation of GIS use. The objective of the remainder of the research was to demonstrate that the use of geographic information and its analysis could be modeled in sufficient detail to pen-nit the identification of costs and benefits attached to all or part of the decision-making process.

Models of how the geographic information was used in the decision-making processes were created as a first step in determining the value of this information. Dickinson chose the petri net technique for modeling. This is a scientific and mathematical tool used to study systems and processes. This technique represents a system in terms of events that occur in the system, a set of conditions or states, and the relationship between the two. The petri net technique also allows the relationships between the conditions and the events to be shown in matrix form. They are represented in matrix form to support the analysis of the modeled system. This researcher used an extension of the basic form of petri nets known as colored petri nets. This extension allows

"tokens" to represent objects and/or information that flow through a system, and different types of "tokens" are allowed in the same petri net. The petri net modeling technique was chosen because it is possible to represent many decision-making components in one model. They are able to model dependent and independent concurrency among components, conditional decision points, feedback and iterative looping, and static and dynamic components of a system.

T1

out
P1
•

T2

in		out
P1	P6	P2
•	1	1
•	2	2
•	3	3

T3

in		out
P7	P2	P3
A	1	J
A	2	K
A	3	L
B	1	M
B	2	N
B	3	P

T4

in	out
P3	P4
J	J
K	K
L	L
M	M
N	N
P	P

T5

in			out
P4	P7	P6	P5
J	A	1	•
K	A	2	•
L	A	3	•
M	B	1	•
N	B	2	•
P	B	3	•

T6

in
P5
•

Example of Colored Petri Net

        The Washington State Department of Natural Resources (WSDNR) was chosen as the case study site. This site was chosen because an extensive analysis was conducted and documented before the GIS was implemented, thereby offering a list of expected uses and products. Another reason was that the agency had been using the GIS for seven years, and this use had been well documented. Four specific tasks were to be modeled: (1) precommercial thinning funding allocation, (2) block planning, (3) old growth commission task force, and (4) fire history reporting.

        Interviews were set up with workers in the four areas to be modeled. Information collected from these interviews was to be used for two objectives:

1. To model, in a structured and detailed way, the use of geographic information and its analysis in the selected decision-making processes, and
2. To track both the costs and benefits of the geographic information and its analysis for selected tasks.

More specific information to be gained from the interviews included:

- The overall goal and specific objectives of the decision-making process
- The steps involved in the decision making process
- The steps involving geographic information
- The manner of geographic information use (and by whom) in each particular step

- The type of benefits derived from having this geographic information available during the decision-making process
- The cost incurred by the user to have this geographic information available

The precommercial thinning funding allocation process was modeled. The benefits of geographic information and analysis determined from the model were:
- Increase in monies made available from Forest Land Management
- Increase in the rate of return on dollars spent on precommercial thinning of stands
- More profitable allocation of precommercial thinning funds

The block planning process also allowed itself for modeling. The benefits in this area were:
- Credibility with the public
- Improved knowledge of areas of concern before on-site activity began
- Ability to perform a more complete alternative study.

Detailed information could not be obtained for the old growth commission task force process, so it was not modeled. Benefits of the GIS and its analysis gathered from the interview included:
- The GIS maps facilitated the process of problem identification by allowing all of the issues to be shown in a geographical context
- The GIS maps facilitated the discussions so that negotiations were performed in an efficient time frame

The fire history process was not modeled either due to the lack of necessary information from outside the WSDNR. The main benefit in this area of the GIS was an increase in funding.

Nedovic-Budic, Zorica. (1999). Evaluating the effects of GIS technology: Review of methods. *Journal of Planning Literature, 13 (3),* 284-295.

This article utilizes the frameworks, methods, and criteria employed in the fields of organizational studies, information management, and decision support systems to evaluate the role of GIS in the planning field. Most evaluations of GIS by planning offices are done before implementation, and are based on the cost-benefit of investing in the system. Post-implementation assessments are rare.

There is a body of work that questions the suitability of GIS software to adequately address the needs of planning practices. Some researchers believe that planners are not taking advantage of GIS's capabilities to perform analyses that are more complex. Research has also shown that GIS has not fully met the expectations of many planning departments. Few planning agencies have profited or recovered the cost of the systems, and there has been a lack of substantial benefits in decision-making. One reason for the gap in expectations and actual results may be the lack of experience by the users.

This article poses seven questions that should be considered in order to develop a process for evaluating GIS in the planning context.
1. What should be measured – tangible or intangible effects; processes or products; outputs or outcomes; policies or programs; operational, management, strategic, or personal effects; internal or external effects; or direct or indirect effects?

2. Should measurements be direct or indirect measures, on-site or off-site measures, or quantitative or qualitative measures? What measurement methods should be used?
3. When should measurement occur, given the maturation of GIS technology and implementation over time?
4. How can reliable and valid measures be obtained by detecting the objective and observable differences between processes or products before and after the introduction of GIS technology? How can we ensure that these differences are the result of GIS technology, and not the result of other factors?
5. Which sampling strategies ensure generalized results since most studies are regionally restricted?
6. Does the suitability, adequacy, and functionality of a GIS change its effect and evaluation? If yes, how?
7. Do contextual or technological factors take precedence? Which types of factors are stronger determinants of the nature and extent of GIS effects?

Based on earlier techniques to evaluate different aspects of GIS and land information systems, Nedovic-Budic uses seven major categories of success to evaluate GIS performance in an urban planning context. These seven categories are: system quality, information quality, information use, user satisfaction, individual effects, organizational effects, and societal effects. The relationship of these categories is illustrated in the model below. The influence of a GIS or information system depends greatly on the first two categories, system quality and information quality.

Nedovic-Budic then describes methods and criteria that can be applied to each of the seven categories.

System Quality

The contents and integration of GIS databases are probably the most crucial system quality issues in the planning context. Planning requires the use of data from many sources, and a GIS system that can integrate with other information systems, allowing easy access to this variety of data, would greatly enhance the quality of this system. The GIS software and the ease with which it can be learned and used are also very important to the quality of the system.

Information Quality

In urban planning quality information is necessary for performing urban analyses and managing and monitoring urban development. In a previous study, Nedovic-Budic identified six aspects of GIS information-related operational effectiveness: data accuracy, availability, collection time, accessibility, currency, and format. In planning and decision making the planning staff, administrators, decision makers, citizens, NGOs, and special interest groups are all affected by the quality of the data.

FIGURE 1. Relationship between the Dimensions of GIS/IS Effects
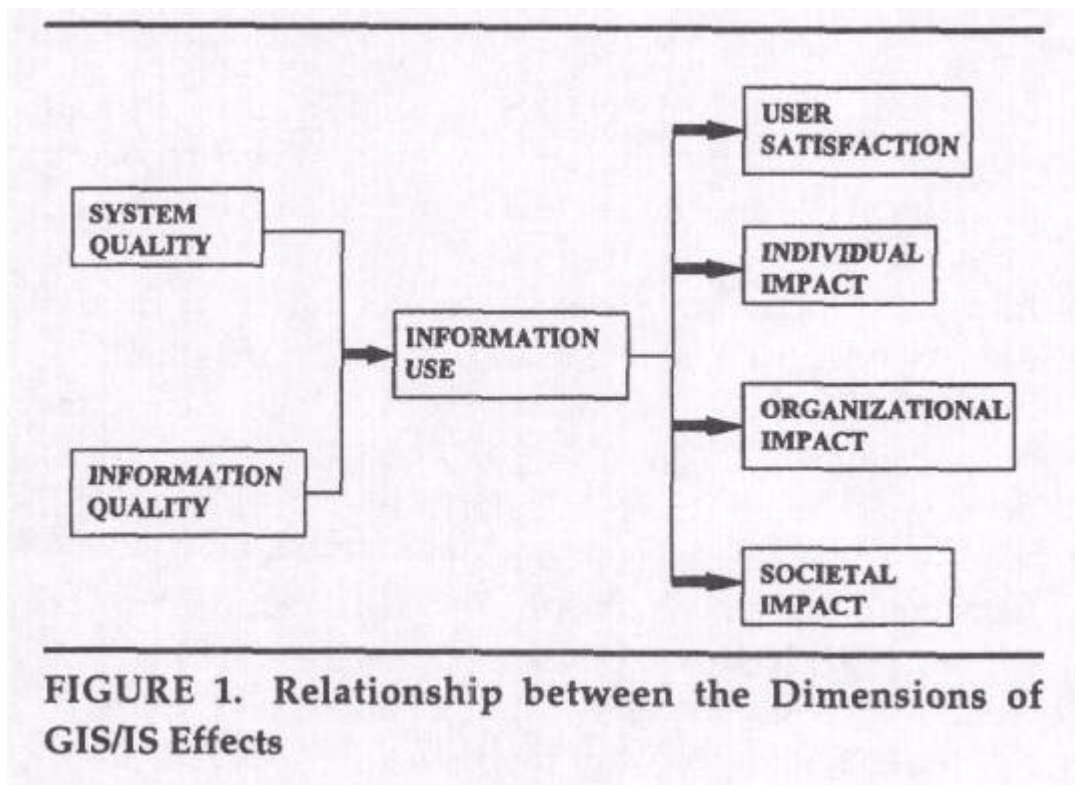
Information Use

       GIS can be evaluated in the planning process by examining the specialized areas in which GIS is applied (land use, transportation, environmental, and economic development), the planning methods aided by GIS technology (impact assessments, systems modeling, and suitability analysis), and the various tasks and functions that are replaced by automated GIS-based tools (data collection, plan making, evaluation of alternatives, and presentations).

User Satisfaction

       In the planning arena there are different groups of GIS users, and each of these groups has different needs that need to be considered.

- Planning Staff – This group sees GIS as a means to simplify work tasks, improve their job performance, increase effectiveness and quality of work, and improve their status as an employee and a professional.
- Administrators and Decision Makers – This group is concerned with managing their organization's resources, and improving the decision-making process.
- Citizens and Special Interest Groups – These users expect GIS to enhance their role in the planning process. This is usually achieved through better access to information. Ultimately, this should lead to the public becoming more influential in plan and policy development.

      Users are also categorized as direct and indirect users. Direct users rely on GIS systems to be easy to learn and use, to handle staff support and documentation, and to be functional for many planning tasks. Indirect users need GIS to provide high quality outputs, up-to-date and accurate

information, and complete information. Indirect users also need GIS outputs to be reliable and have easily understandable formats.

Individual Effects
>It is important that everyone involved in the decision making process be provided with the appropriate information and understand it. To better understand the role GIS plays in this process you should look at how GIS affects the identification of conflicts, understanding of problems, decision-making time, explicitness of decisions, confidence in analysis, support in finding solutions, and communication of information.

Organizational Effects
>This addresses how GIS assists in organizational tasks such as the storing, retrieving, manipulation, and graphic or non-graphic display of information; reviewing development proposals; issuing building permits; and answering rezoning questions and requests.

Societal Effects
>GIS is viewed as a tool that will enhance public participation in the planning process. The issue of equal opportunity needs to be addressed in evaluating results in this area. Initial evidence indicates that disadvantaged communities and populations have limited access to information technology, and therefore would not have the same chances to utilize information provided via this medium.

Nedovic-Budic, Zorica, and Pinto, Jeffery K. (1999). Understanding interorganizational GIS activities: a conceptual framework. *Urban and Regional Information Systems Association Journal, 11 (1),* 53-64.

>The greatest benefit from the coordinated GIS departments and database sharing is reduced redundancy and duplication of effort and establishment of data partnerships and networks that are the building blocks of the National Spatial Data Infrastructure. A better understanding of the motivations and processes that are likely to influence the exchange of geographic information is the first step in improving the efficiency and effectiveness of this data sharing process. One finding of this research was that much of the resistance to data sharing is not related to incompatible systems or data structuring, but lies in human factors that impede free data sharing across organizational lines.
>This paper presents a framework for understanding various aspects in the process of developing and sharing digital data generated by GIS technology. The framework includes organizational and interorganizational context, motivation, coordination mechanisms, and outcomes of sharing GIS and databases.
>Concepts dealing with intensity and quality of interorganizational relationships, organizational interdependence, resources, structure, stability, culture, politics, and leadership are the most important for understanding multi-participant GIS.
>The motivation for interorganizational GIS and data sharing can range from economic and socio-political to technical arguments. Sense of duty, common interest, or exchange inducements may lead to these joint efforts.
>Coordination mechanisms are created through interorganizational structures, processes, and policies. Structure consists of organizational forms; channels, direction, and methods of information flow; and extent of shared hardware, software, personnel, space, and applications. Coordination can be achieved through joint planning, standardization, or mutual adjustment. Formal or informal policies are created to address data-related topics, responsibilities, ownership, contributions, and incentives.

Efficiency, effectiveness, impact on decision-making, societal equity, and public service can be used as criteria for evaluating the outcomes of interorganizational GIS. One of the most important expected benefits from this type of information sharing system is the development and strengthening of regional and local networks and partnerships.

Nedovic-Budic, Z. (1998). The impact of GIS technology. *Environment and Planning B: Planning and Design, 25,* 681-692.

Due to the fact that GIS systems are expensive to implement and maintain, many of the evaluations that are done are cost-benefit analysis. There is much attention given to ways that monies spent on GIS can be recovered, such as selling data and GIS services or by controlling the access to digital spatial databases. These types of evaluations are inadequate to offer an understanding of what planners need and want from the new tool, what they get from it, and how they are impacted by it.

Many benefits of GIS are underestimated because the systems are not measured against the do nothing or manual methods. The first step in evaluating GIS as it affects organizational functions and processes is to establish multiple criteria. This paper uses the following seven evaluation categories: system quality, information quality, system use, user satisfaction, individual impact, organizational impact, and societal impact. System quality and information quality greatly influence the remainder of the evaluation categories.

The most improved aspect of information quality has been data accuracy. The predominant uses of GIS have been in the activities of data storage, retrieval, dissemination, and communication. Advanced uses of GIS, such as analytical and synthesis-oriented tasks, are less frequently used. However, when these more advanced uses are applied, the GIS has a greater effect. Only 30% of respondents in a survey of British authorities felt that GIS contributed to better decisions, and less than half of respondents in US government settings felt that GIS contributed to better decisions. Two aspects of decision-making where improvements were noted were communication of information and confidence in analysis. Reduction in the costs of data collection has been the main improvement in the area of organizational impact.

Previous researchers warn of the problems triggered by the use of GIS. They warn of the difficulties in keeping the promises of liberation and empowerment that this new technology brings. They warn that visualization and imaging capabilities of GIS technology could be used to promote particular views of the world, to reinforce power in controlling the access and use of information and other resources, to create new cultures and communities, and to invade privacy.

It is suggested that future evaluation research focus on specific applications in order to conduct a more informed and context-based study, instead of evaluating the GIS technology within the context of an entire organization.

Pullar, David V., and Tidey, Margo E. (2001). Coupling 3D visualization to qualitative assessment of built environment designs. *Landscape and Urban Planning, 55 (1),* 29-40.

Planners assess the merits of proposed changes using visual impact assessment (VIA). The authors believe that to facilitate VIA in planning and design requires visualization and a structured evaluation technique to arbitrate the decision-making process. This paper describes how this process was applied to the decision-making process for selecting a design for a proposed new library extension at the University of Queensland. The study hoped to achieve consensus among all stakeholders. The stakeholders included architects, engineers, facility managers, library staff, and interested individuals from the campus community. The first part of the case

study was conducted over the Internet for viewing impacts of proposed landscape and building changes, and for stakeholders to enter and receive feedback on opinions.

VIA is the formal process used to evaluate the visual merits of a proposed development with respect to passive human interaction. It begins with some analysis of the objectives based on gathered information, followed by systematic evaluation of the design options, and ending with the choice of the best option.

Interactive visualizations can help create and present good decisions that help lead to consensus. Providing an information rich environment helps engage stakeholders. Hypertext information can be linked to the 3D model to provide better understanding of the data and overall situation. Visualization alone does not guarantee collaborative decision-making. Collaborative planning requires debate, negotiation, and grouping of opinions to reach a final decision. The use or structured decision models allows the decision-making process to be traced, and therefore validated. The decision technique used here was the Delphi process. This technique involves sets of rounds conducted with stakeholders to anonymously evaluate, modify, and re-evaluate proposals until a consensus is reached.

This study found that there was support for the use of 3D GIS in urban and landscape planning. The researchers also found that at the current time, 3D GIS was far from ideal for enabling the communication of data and visualizations to a group. Future enhancements in virtual reality that will allow the user to manipulate the simulated world, explore hypertext, and interact with the virtual model are believed to help overcome the problems faced in this project.

Zwart, Peter. (1991). Some Indicators to measure the impact of land information systems in decision making. Mark J. Salling (Editor), *Urban and Regional Information Systems Association Proceedings, 4*. Washington D.C.: URISA.

For many it is presumed that the use of GIS will automatically lead to better decision-making. This belief is hardly questioned or qualified. In order to assess the impact information from GIS and Land Information Systems (LIS) has on decision-making there must first be a neutral, verifiable criteria by which to judge this impact. The criteria should determine:
1. Whether the information from a GIS/LIS is used in making a decision, and if so, how is it used, and
2. In what kinds of decisions is GIS/LIS information used and do these, in turn, contribute to the fulfillment of the decision maker's goal or the program's aims.

The criteria should meet six minimal conditions: they should
1. Be plausible,
2. Have actively intervened,
3. Yield comparative levels of utilization in more than one context,
4. Contrast,
5. Exhibit covariance, and
6. The information should have temporal precedence, that is it should have been used before its impact has been noted.

This method helps evaluate the role of GIS on the final outcome; other methods have discussed evaluating GIS throughout the entire process.

There is a difference in the two ways information is used. Instrumental use applies specific knowledge to a specific problem; it effects a specific decision. Conceptual use brings about a change in awareness; it has a conscious-raising effect on the decision maker. Conceptual use must precede instrumental use.

GIS/LIS not only provide information for action, but they may also generate ideas, and lead the decision-makers in new directions.

The researcher also addresses the degree to which the information is used.

1. Not Referred To: Use at the lowest level involves producing information that is in no way referred to by the people for whom the information is intended.
2. Referred To: Information is referred to by the decision maker, but it is not influential enough to change, strengthen, or weaken a previous decision.
3. Supports Values or Decisions: Information reinforces preconceived decisions by legitimizing them.
4. Changes Values or Decisions: The highest level of use is information that changes the initially preferred alternative or outcome, information for action perspective.

Zwart also considers the importance of the decision that the information is being used for: important or not so important.

This criteria guideline leads us to four classes of impacts the information has had on decision-making.

Group I: High use, high impact. Information is used instrumentally. Utilization and impact should be observable and lend itself to quantification.

Group II: High use, medium impact. Impact of information through its conceptual use. Lower observable level of impact, and measuring its effect will be less direct.

Group III: High use, low impact. Information is used extensively in situations to support less important decisions. Effects should be observable and capable of quantification.

Group IV: Low use, low impact. Information is acknowledged but not utilized. It has little or no effect on the final decision. Its absence may be observable.

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